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Identification of Fatty Acids in Edible Wild Plants by Gas Chromatography

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Abstract Human beings evolved on a diet that was balanced in the omega-6 and omega-3 polyunsaturated fatty acids (PUFA), and was high in antioxidants. Edible wild plants provide alpha-linolenic acid and PUFA. Today, we know that omega-3 fatty acids are essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery disease, hypertension, diabetes, arthritis, other inflammatory and autoimmune disorders, and cancer. Comparison of obtained results from analysis of fatty acids of edible plant oils showed that *Solanum* oil has the highest nutritional value because it contains high contents of linoleic acid (62.29%) and oleic acid (8.6%) and *Asparagus* oil has high nutritional value because it contains 66.12% oleic acid and 9.6% linoleic acid. Comparison of results of this study with reported results by Artemis (2004) showed that palmetic acid (34.48%) and estearic acid (21.71%) contents of *portulaca* in this study were greater than the results reported by Artemis. Therefore, we can conclude that *Solanum* and *Asparagus* oil are edible and have good nutritive values.

Keywords Fatty Acids · Nutritive Values · *Solanum* and *Asparagus* · Iran · India

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Introduction

In developing nations, numerous types of edible wild plants are exploited as sources of food; hence, they provide an adequate level of nutrition to the inhabitants (Aberoumand 2008). Nutritional information is used increasingly by public agencies and agricultural industries to promote fresh produce. Consumers are looking for variety in their diets and are aware of the health benefits of fresh fruits and vegetables. Of special interest are food sources rich in antioxidants (Aberoumand and Deokule 2008). Conjugated linoleic acids (CLA) are a group of positional and geometrical isomers of linoleic acid (LA) with a conjugated double bond system. The major natural sources of CLA are fat tissues of ruminants (meat and dairy products). The *cis*9,-*trans*11 (c9, t11) isomer is the most abundant natural isomer (about 75–90% of total CLA), which is also called rumenic acid (Gnadig et al. 2003). Studies (in vivo and in vitro) have revealed biological activities of CLA including antioxidative, anticarcinogenic, antiatherosclerotic, antidiabetogenic, and antiobesity properties, along with immune-enhancing effects (Flintoff-Dye and Omaye 2005; Wang and Jones 2004).

Different methods, such as dehydration of ricinoleic acid (Yang et al. 2002), photoproduction of CLA (Gangidi and Proctor 2004), and alkaline isomerization of LA or LA-rich oils (Berdeaux et al. 1998), are used to synthesize CLA. Alkaline isomerization of LA is usually used for commercial production of CLA containing two isomers, c9,t11 (43–45%) and t10,c12 (43–45%), accompanied by small amounts of other CLA isomers (Wang and Jones 2004); however, since the biological activity of the product is due to the presence of both isomers, a purification step would be necessary. Urea-inclusion crystallization has been generally employed to concentrate useful polyunsaturated fatty acids and CLA in edible oils (Hayes 2006).

Although CLA have several beneficial effects, the consumption of CLA has decreased due to the replacement of milk and animal fats by vegetable oils. Enzyme-catalyzed acidolysis is an approach to increase the CLA content in structured lipids (SL). Several researches of enzymatic interesterification of CLA with fats and oils were reported; Garcia et al. (1998, 2000) prepared SL from butter and fish oils with CLA by enzymatic acidolysis. Ortega et al. (2004), using a lipase, incorporated CLA in fully hydrogenated soybean oil; Lee et al. (2003, 2004) reported the interesterification of CLA with soybean, sunflower, and safflower oils. The altered composition of triacylglycerols in SL (incorporation of CLA) provides different changes in physical and chemical characteristics of SL compared to the initial lipid, which possibly improve the functional properties of the oil. The objective of this study was to produce high-purity CLA from safflower oil and the incorporation of this functional ingredient into canola oil to prepare CLA-rich tria-cylglycerols (TG) by enzymatic interesterification and to compare the TG with the starting lipid with respect to physical and chemical properties.

Material and Methods

Collection of Samples

Eight different types of fruits and vegetables (*Alocacia indica Sch*., *Asparagus officinalis DC*., *Chlorophytum comosum Linn*., *Cordia Myxa Roxb*., *Eulophia Ochreata Lindl*., *Momordica dioicia Roxb*., *Portulaca oleracia Linn*., and *Solanum indicum Linn*.) were collected from various localities of Maharashtra (India) and Iran. Five wild edible plants from between eight different types of fruits and vegetables in this study were collected from Iran, viz., *Asparagus officinalis*, *Chlorophytum comosum*, *Codia myxa*, *Portulaca oleracia*, and *Solanum indicum* were collected from Iran.

Samples Preparation

Fresh fruits and vegetables were cleaned with water and external moisture was wiped out with a dry cloth. The edible portions of the individual fruits were separated and dried in a hot air oven at 50 °C for 1 h. The dried samples were powdered in blender for further study. Some of the plants were dried under shade so as to prevent the decomposition of chemical compounds.

Chemicals and Instruments

1. Chemicals: methanolic HCl (0.2 M), methanolic NaOH (0.1 M), heptadecanoic acid (17:0) as internal standard, 0.5 N KOH solution (20% ethanol, 20 mL), hexane (40 mL), 0.5 NKOH (20% ethanol), saturated NaCl (10 mL) solution, and anhydrous sodium sulfate column
2. Instruments: gas chromatograph (CP9002; Chrompac), rotary vacuum evaporator, a separatory funnel with a stopcock, and Soxhlet apparatus

Extraction of Plant Oil

The oils were extracted using hexane as solvent. Hexane (1,500 mL) was added to 500 g of milled plants and extraction was performed for 24 h at room temperature; this operation was done twice to complete the oil extraction from the plants. The solvent were then removed by rotary vacuum evaporator and the plant oils were stored in a dark container in a refrigerator for the subsequent steps.

Determination of Fatty Acids of Plant Oils

To determine the fatty acid profile of plant oil, the oil was methylated according to the AOAC method. Methylated samples (1 mL) were injected into a gas chromatograph (CP9002; Chrompac) equipped with a flame ionization detector and the fatty acid methyl esters were separated using FFAP-CB fused-silica WCOT (25 m 60.32 mm 60.3 mm) and helium gas as a carrier with an inlet pressure of 75 kPa. The temperature program was as follows: increasing from 40 to 100 °C at a rate of 107 °C/min and holding for 0.2 min, then increasing to 240 °C at 257 °C/min and holding for 30 min at 240 °C. The temperatures of the injector and detector were 230 and 250 °C, respectively.

Results and Discussion

Comparison of obtained results from the analysis of fatty acids of edible plant oils showed that *Solanum* oil has the highest nutritional value because it contains high contents of LA and oleic acid, Asparagus oil has high nutritional value, *Alocacia* oil has medium nutritional value, and *Portulaca* oil has low nutritional value because it contains only saturated fatty acids such as estearic acid and palmetic acid. Any edible plant oils contain linolenic acid (Figs. 1, 2, 3, and 4).

Paola Benatti et al. (2004) reported that LA and linolenic acid contents in Asparagus and Portulaca was 70 mg/100 g, 6 mg/100 g, 89 mg/100 g, and 405 mg/100 g. LA and linolenic acid contents of Asparagus and Portulaca in this study were not detected. Comparison of results reported by Paola Benatti et al. with results of this study showed that

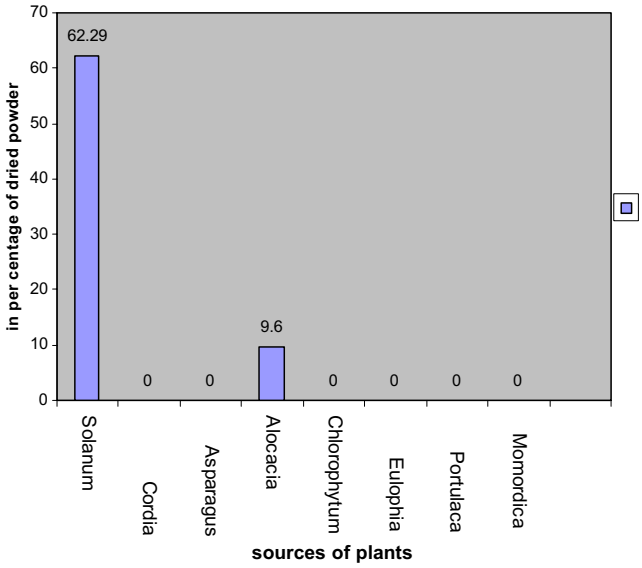

Fig. 1 LA contents of eight edible plants

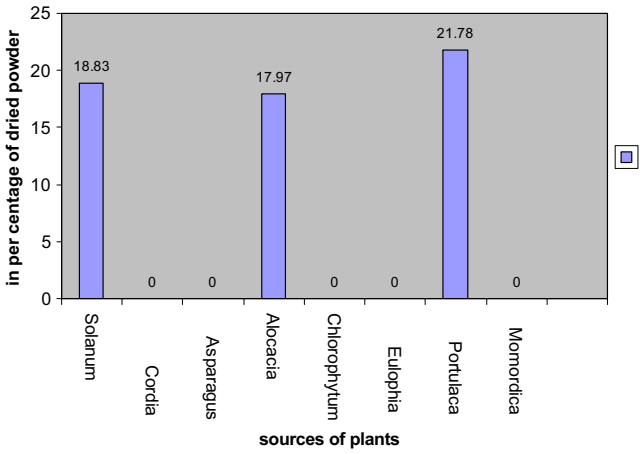

Fig. 3 Estearic acids contents of eight edible plants

LA and linolenic acid contents of Asparagus and Portulaca obtained from the work of Paola Benatti et al. was greater than the reported results.

Artemis (2004) reported palmetic acid (0.81) and estearic acid (0.20) contents of Portulaca in milligrams per gram of wet weight. Comparison of results of this study with results reported by Artemis (2004) showed that palmetic acid (34.48%) and estearic acid (21.71%) contents of portulaca in this study were greater than the results reported by Artemis.

Concluding Remarks

Studies on wild edible plants relative to the omega-3 fatty acids and antioxidant content are being carried out in various parts of the world. As expected, they show enormous variation in the content of both omega-3 fatty acids and antioxidants due to variation in climatic conditions and cultivars. In developing new sources of food, the study of the dietary composition of wild edible plants is essential. Their cultivation should lead to increased production of plants rich in omega-3 fatty acids and antioxidants, both of which reduce the risk of chronic diseases.

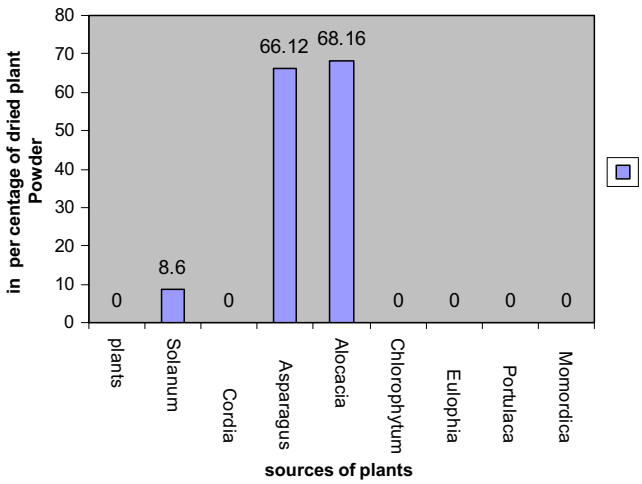

Fig. 2 Oleic acid contents of eight edible plants oil

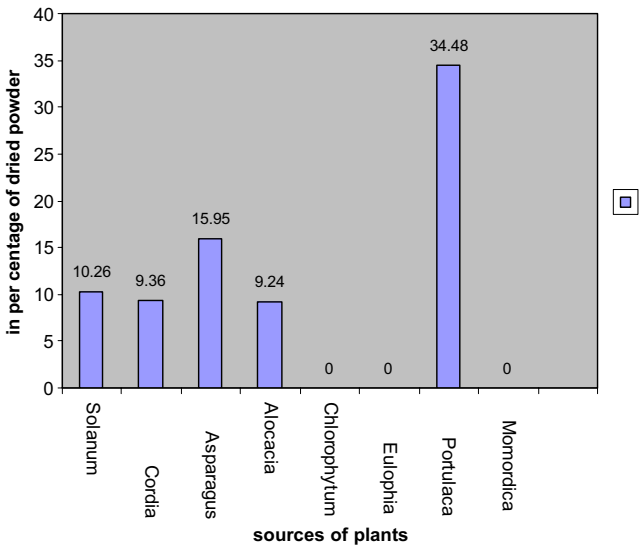

Fig. 4 Palmetic acids contents of eight edible plants

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